Golden State Examination

GSE

Teacher Guide

for

Laboratory Sciences

Biology

Chemistry

Second-year Coordinated Science

Physics

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2000

CALIFORNIA DEPARTMENT OF EDUCATION

This document has been prepared by the San Luis Obispo County Office of Education under contract with the California Department of Education. For information about the Golden State Examination testing dates, registration materials, and procedures or information about the Golden State Seal Merit Diploma, contact:

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We wish to acknowledge the following teachers and other educators who contributed to the development of the Golden State Examinations in biology, chemistry, second-year coordinated science, and physics:

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Table of Contents

Introduction

Using the Golden State Examination Teacher Guide

The *Golden State Examination Teacher Guide* has been developed to provide essential information and preparation guidelines for teachers. The guide is intended to serve as an instructional aid in the classroom. The guide is divided into the following sections:

Test Content — describes the content upon which the Golden State Examination (GSE) questions have been developed.

Test Structure — describes the format of the test.

Scoring Guides — outlines the criteria used to score laboratory responses and the written response.

Sample Questions — includes a variety of sample questions, representing the types of questions found on the examinations.

Teachers are encouraged to reproduce portions or all of the guide for classroom use. Districts/schools also can use these materials for staff development.

Student Eligibility

The Golden State Examinations in biology, chemistry, second-year coordinated science, and physics are given during the spring test administration. Each examination may be taken only once.

These are end-of-course exams. Students who are enrolled in the course at the time the examinations are given and students who have taken the course since the spring 1999 test administration may take the exams.

Test Preparation

Students should have a firm foundation in the knowledge and skills needed to master the subject area. Sound preparation for the Golden State Examinations should include classroom assignments that allow students to use and test their knowledge.

Students preparing for the examinations need to be able to articulate the major ideas and concepts in the subject area being tested. They must be able to analyze information, apply knowledge, solve problems, and organize evidence to explain findings from laboratory experiments.

In accordance with the 1999–2000 state budget, the content of the current Golden State Examinations will be reviewed to ensure their full alignment to the content standards adopted by the State Board of Education. Teachers should review their curriculum and instructional activities for alignment to these standards.

Reporting Results

All students who complete both sessions of the GSE in biology, chemistry, physics, or second-year coordinated science receive an individual report of results. Scores for the multiple-choice and written-response portions of the exam are combined to produce the student's overall achievement level. There are six achievement levels. Students who achieve level six are awarded high honors; those who achieve level five are awarded honors; and those who achieve level four are awarded recognition. Students who achieve levels three or below are acknowledged for their participation. Results for the spring administration are mailed in October.

Resource Document

The pre-publication version of the *Science Content Standards, Grades K–12* is available at http://www.cde.ca.gov/board/board.html on the Internet.

Other Resources

The *Science Framework for California Public Schools* is available from the Publications Division, Sales Office, California Department of Education, P.O. Box 271, Sacramento, CA 95812-0271; 1-800-955-4099 ext. 6.

Testing schedules and other information are available from the GSE coordinator in your district office, county office of education, or the California Department of Education at http://www.cde.ca.gov/cilbranch/sca on the Internet.

Test Content for Biology, Chemistry, Second-year Coordinated Science, and Physics

The content of Golden State Examinations in biology, chemistry, second-year coordinated science, and physics is being aligned to the *Science Content Standards, Grades K–12,* adopted by the State Board of Education. For additional details about the topics covered on the exams, teachers should refer to these adopted standards. A complete listing of the science standards is available at http://www.cde.ca.gov/board/board.html on the Internet.

Another useful source document is the *Science Framework for California Public Schools*.

The examinations emphasize the understanding of fundamental scientific concepts and the themes that are interwoven throughout the diverse areas that comprise modern science. Questions on these examinations address the following strands:

Biology

- Molecular and cellular biology: nature and role of biological molecules; cellular structure and function; cell reproduction (mitosis and meiosis); respiration and photosynthesis
- Functional biology: structure/function relationships; regulatory processes; taxonomic groups including humans, vertebrates, invertebrates, plants, fungi, and protists
- Ecological principles and applications: basic ecology including populations, communities, and ecosystems; energy flow and biochemical cycles; species interactions; human-environment interactions
- Genetics and evolution: meiosis; Mendelian genetics; population genetics; patterns and processes of evolution; species concept and systematics; natural selection

Chemistry

- Basic foundations: atomic and molecular theory, notations, formulas, and models; stoichiometry, equations, mole concept; Periodic Table (organizations, trends, and applications); physical properties (density, etc.)
- States of matter: properties of solids, liquids, gases; changes of state, energy changes; gas laws (relationships and applications); solutions
- Bonding: principles of ionic, covalent (polar and nonpolar), and metallic bonding; attractions among particles (polar and non polar interactions, relationship to physical and chemical properties)
- Reactions: reactions in aqueous solution (precipitation, acid-base, oxidations-reduction); equilibrium and rates of reaction; energy changes during reactions; practical applications

Second-year Coordinated Science

- Earth and space sciences: structure of the earth and geological processes; oceanography; meteorology and atmospheric sciences; the flow of matter and energy resources
- Life science: molecular and cellular biology; functional biology of organisms, systems, levels of organization; ecological principles and applications (populations, communities, ecosystems, habitat change, flow of matter and energy); genetics, evolution, and diversity (species, adaptations, life cycles, mechanisms of heredity and evolution)
- Physical science: structure and properties of matter (physical and chemical properties, elements, compounds and mixtures; atoms and molecules; types of bonding), reactions and interactions (chemical and physical change, change in properties of solutions with concentration); forces and motion, energy (forms and transformations; conservation principles, energy resources)

Physics

- Mechanics: motion in one and two dimensions; forces in equilibrium, how a net force causes changes in motion, work, energy, power, momentum, the conservation laws, uniform circular motion, simple harmonic motion, planetary motion, and relativity
- Matter: kinetic theory; difference between heat, temperature, and internal energy; the properties of ideal gases; quantum phenomena
- Electricity and magnetism: static electricity, electric forces, fields, and potentials, DC circuits, magnetic forces and fields, and electromagnetic induction
- Waves: general properties of all wave phenomena, sound, and optics

Test Structure for Biology, Chemistry, Second-year Coordinated Science, and Physics

The Golden State Examinations in biology, chemistry, second-year coordinated science, and physics are two-part examinations, administered in two 45-minute sessions.

Session one for biology, chemistry, second-year coordinated science, and physics consists of multiple-choice questions. The questions are designed to cover the breadth of the subject area within the content specifications. An emphasis is placed upon questions linked to a scenario, diagram, illustration, or data table. Included in the multiple-choice questions is at least one question requiring interpretation skills using a table, one using a graph, and one using a figure.

The multiple-choice portion of the examinations is machine scored. Sample multiple-choice questions, similar to those on the examinations, are on pages 8–9 for biology, pages 13–14 for chemistry, pages 18–20 for second-year coordinated science, and pages 26–27 for physics. Answer keys are provided.

Session two consists of a laboratory experiment (Part A) and an application question (Part B). Each part will be scored separately. Students should plan on spending about 30 minutes on Part A and 15 minutes on Part B. This is a new format for Session two.

The laboratory task is performed independently by each student at individual laboratory stations. Only one laboratory task in each subject area is administered to all students in a particular year. Different tasks will be used in subsequent years. The laboratory tasks require students to use laboratory equipment and chemicals under supervised and safe conditions.

Students should be prepared to:

- show an understanding of appropriate laboratory procedures.
- document observations and data in an accurate and detailed manner.
- support all analyses, calculations, and conclusions with specific evidence.
- use scientific arguments to demonstrate their knowledge of scientific methods, concepts, and principles and their application to real-life situations.

The written-response questions require students to use information gained in the laboratory task to solve problems, demonstrate knowledge of concepts and their application, make inferences, draw appropriate conclusions, and explain solutions.

The 1999 sample laboratory tasks have been adapted to the new 2000 lab task format. Sample laboratory tasks are on pages 10–12 for biology, pages 15–17 for chemistry, and pages 21–25 for second-year coordinated science. The GSE in physics is a new examination; therefore, a sample laboratory task is not available.

The written-response questions and laboratory tasks are scored by experienced science teachers and other professionals in the field.

Teachers are encouraged to duplicate this guide for student use and to have students test themselves with the sample questions and laboratory tasks.

Preparing for Administration of Laboratory Tasks

Each student performs the laboratory task individually using laboratory materials and equipment set up at testing stations before the test administration. The General Instructions for the Session Two Laboratory Task and Teacher/Proctor Instructions provided in the *Administration Manual for Laboratory Sciences* include information, instructions for station setup, and a list of materials to be provided by the school (e.g., waste containers, goggles, paper towels). Most laboratory materials are provided in individual lab kits that arrive several days prior to the test administration. Please note that some tasks require that materials be prepared at least one day before test administration.

For a class of 30 students, a teacher needs to set up 30 stations. Students may be tested in multiple sessions. Therefore, the teacher needs to check each testing station, verify that all required materials are present, and replenish any materials that have been used up or broken before the next class enters the room. Physical visual barriers must be constructed and set up between the testing stations. The room in which the tests are administered should have any scientific charts removed or covered.

It is recommended that there be at least one additional person, such as a responsible student aide, parent assistant, or another teacher, in the testing room to assist in the administration of the laboratory task and collection of test materials. Help is needed to pass out materials, collect waste, replenish materials, and check stations.

Scoring Guide for Laboratory Tasks

The laboratory task portion of the Golden State Examinations in biology, chemistry, second-year coordinated science, and physics is scored using criteria based on the general scoring guide below.

A detailed training package for scorers, addressing what students are expected to accomplish on each laboratory task, is developed to score the student response.

Score Point 6

Student responses show excellent knowledge and understanding of scientific concepts and the use of scientific methods to solve problems presented in the laboratory task. The responses:

- demonstrate extensive knowledge of the methods, concepts, and principles of science through excellent and accurate observations, measurements, diagrams, analogies, mathematical calculations, data analysis, and use of relevant terms
- demonstrate recognition and correct application of scientific theory
- make connections between laboratory activities and interdisciplinary themes of science
- complete all requirements of the laboratory task and analysis questions
- show high level of scientific reasoning
- convey knowledge and ideas correctly, clearly, and effectively and, when appropriate, include detailed diagrams, charts, tables, and graphs

Score Point 5

Student responses show strong knowledge and understanding of scientific concepts and the use of scientific methods to solve problems presented in the laboratory task. The responses:

- demonstrate detailed knowledge of the methods, concepts, and principles of science through accurate observations, measurements, diagrams, analogies, mathematical calculations, data analysis, and use of relevant terms
- demonstrate recognition and correct application of scientific theory
- make connections between laboratory activities and interdisciplinary themes of science
- complete most requirements of the laboratory task and analysis questions
- show strong level of scientific reasoning
- convey knowledge and ideas correctly and clearly and, when appropriate, include diagrams, charts, tables, and graphs

Score Point 4

Student responses show good knowledge and understanding of scientific concepts and the use of scientific methods to solve problems presented in the laboratory task. The responses:

- demonstrate overall knowledge of the methods, concepts, and principles of science through generally correct observations, measurements, diagrams, analogies, mathematical calculations, data analysis, and use of relevant terms
- demonstrate recognition and correct application of scientific theory
- make connections between laboratory activities and interdisciplinary themes of science
- complete many requirements of the laboratory task and analysis questions
- show scientific reasoning
- convey knowledge and ideas in a generally correct and clear manner and, when appropriate, include diagrams, charts, tables, and graphs

Score Point 3

Student responses show basic knowledge and understanding of scientific concepts and the use of scientific methods to solve problems presented in the laboratory task. The responses:

- demonstrate basic knowledge of the methods, concepts, and principles of science through general observations, measurements, diagrams, analogies, mathematical calculations, data analysis, and use of relevant terms
- demonstrate recognition of some facts and scientific theory
- make few connections between laboratory activities and interdisciplinary themes of science
- complete some requirements of the laboratory task and analysis questions, but some aspects may be flawed
- show some scientific reasoning
- convey knowledge and ideas in a basic manner

Score Point 2

Student responses show limited knowledge and understanding of scientific concepts and the use of scientific methods to solve problems presented in the laboratory task. The responses:

- demonstrate limited knowledge of the methods, concepts, and principles of science; some observations, measurements, diagrams, analogies, mathematical calculations, data analysis, and relevant terms may be missing or faulty
- provide limited evidence of recognition of facts and scientific theory
- make limited connections between laboratory activities and interdisciplinary themes of science
- complete very few requirements of the laboratory task and analysis questions, and responses are largely incomplete or flawed
- show limited scientific reasoning
- convey knowledge and ideas in a limited manner

Score Point 1

Student responses show little or no knowledge and understanding of scientific concepts and the use of scientific methods to solve problems presented in the laboratory task. The responses:

- demonstrate minimal knowledge of the methods, concepts, and principles of science
- provide little evidence of recognition of facts and scientific theory
- demonstrate little or no knowledge of connections between laboratory activities and interdisciplinary themes of science
- give incomplete and unsubstantiated responses to observation and analysis questions
- show little or no scientific reasoning
- convey knowledge and ideas in a manner that interferes with comprehension

Scoring Guide for Laboratory Task Application Questions

The task application portion of the Golden State Examinations in biology, chemistry, second-year coordinated science, and physics is scored using criteria based on the general scoring guide below.

A detailed training package for scorers, addressing what students are expected to accomplish on each question, is developed to score the student response.

Score Point 4

The student response shows thorough knowledge and understanding of the scientific concepts presented in this task. The response:

- correctly and appropriately applies knowledge and information drawn from the laboratory task, the application question, and the study of science
- provides explanations that show a high level of reasoning, are logical, and are clearly supported
- employs terminology appropriately and accurately
- may contain errors so insignificant that they do not detract from overall understanding
- communicates clearly, coherently, and effectively

Score Point 3

The student response shows substantial knowledge and understanding of the scientific concepts presented in this task. The response:

- appropriately applies knowledge and information drawn from the laboratory task, the application question, and the study of science
- provides explanations that show a sound level of reasoning, although explanations may lack detail or may not be clearly supported
- employs mostly appropriate and accurate terminology
- contains a few errors and omissions that detract little from understanding
- communicates clearly

Score Point 2

The student response shows basic or partial knowledge and understanding of the concepts presented in this task. The response:

- attempts to apply knowledge and information drawn from the laboratory task, the application question, and the study of science
- provides explanations, but reasoning and explanations may be flawed or may describe rather than explain
- employs misconceptions in terminology
- contains several errors and omissions
- communicates in a basic manner; errors in expression may hinder effective communication

Score Point 1

The student response shows little or no knowledge and understanding of the concepts presented in this task. The response:

- may attempt to provide an explanation, but it is incomplete, unsubstantiated, incorrect, off topic, or restates the application question
- demonstrates seriously flawed reasoning
- communicates minimally; errors in expression limit communication

Sample Multiple-choice Questions for Biology

Use the information provided in the table to answer questions 1 and 2.

Test Tube	Contents of Test Tube	Initial Color of Solution in Test Tube	Color after 30 minutes
1	• water	clear	clear
2	• water • 4 drops indicator	blue	blue
3	• water • 4 drops indicator • acid	blue	yellow
4	• water • 4 drops indicator • base	blue	red
5	• water • 4 drops indicator • Organism X	blue	yellow

1. Which of the five test tubes represents a control?

   A. 2

   B. 3

   C. 4

   D. 5

2. What could you conclude from this experiment given only the indicated information?

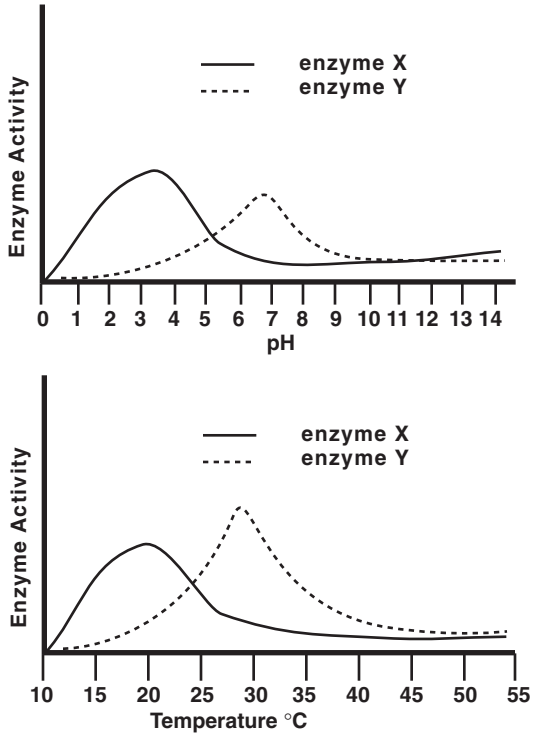
   A. Organism X produced a substance that resulted in a pH greater than 7.

   B. Organism X produced a substance that resulted in a pH lower than 7.

   C. Organism X is a plant.

   D. Organism X is an animal.

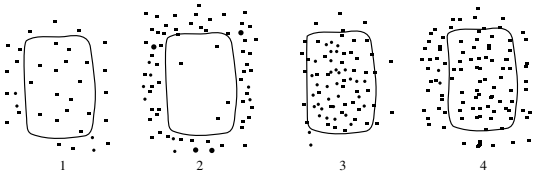
3.



What are the ideal conditions for enzyme Y?

	pH	**Temperature**
A.	pH 3	30 °C
B.	pH 7	37 °C
C.	pH 5	37 °C
D.	pH 7	30 °C

4.



The diagram above shows four cells immediately after they were placed in solutions with different concentrations of glucose (small) molecules. The dots in the diagram represent glucose molecules.

In which of the cells will there be a net loss of water?

A. 2 only

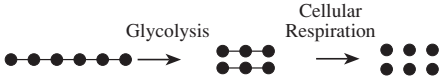
B. 1 and 2

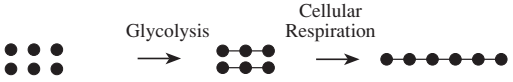
C. 3 only

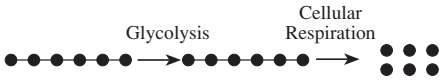
D. 3 and 4

5. Which of the following most closely represents what happens to a glucose molecule during aerobic cellular respiration?

(Note each • represents a carbon atom)

A. 

B. 

C. 

D. 

6. Recombinant DNA technology, which allows bacterial cells to make human insulin, is possible because all organisms

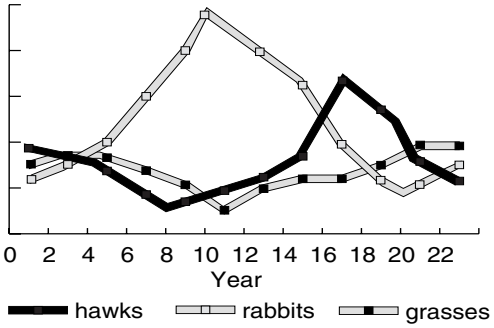
A. have the same chromosomes.

B. make the same proteins.

C. have the same organelles.

D. use the same genetic code.

Use the following graph to answer questions 7 and 8.



7. The graph above shows the changes in the population sizes of grasses, rabbits, and hawks living in an ecosystem over a 22-year period.

Which is a possible explanation for changes in the rabbit population between year four and year ten?

A. an increase in the number of competitors

B. a decrease in food availability

C. a decrease in the hawk population

D. destruction of the rabbits' habitat

8. If a disease destroyed the hawk population during year 22, the grass population would **MOST** likely _____ over the next 5–6 years.

A. increase

B. decrease

C. remain steady

D. become extinct

Biology Answer Key

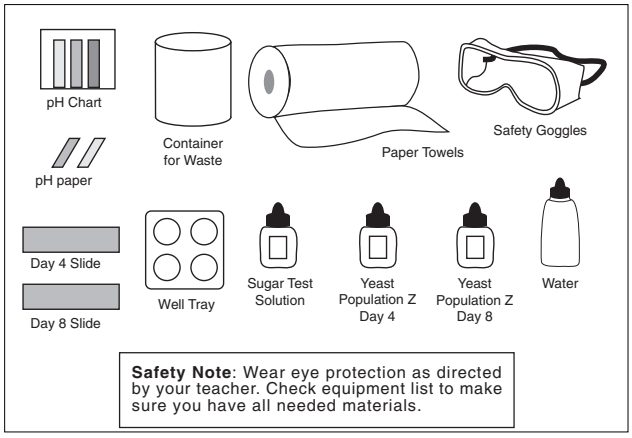
1. A	4. A	7. C
2. B	5. A	8. B
3. D	6. D	

Sample Laboratory Task for Biology

Title: Yeast Population

Laboratory Materials

On the table in front of you, you will find the following:



This task consists of a laboratory experiment, Part A, and an application question, Part B. They will be scored separately. Your final score will be based on your answers to both Part A and Part B. You should plan on spending about 30 minutes on Part A and 15 minutes on Part B.

Directions

These instructions will not be repeated during the procedures.

Read and follow the steps of this lab in the order given.

Record all observations, results, and answers to the questions as directed.

Immediately notify your instructor of spills, missing equipment, or other problems.

STATEMENT OF THE TASK

A population is a group of individuals that live in the same place at the same time. The number of individuals in a population can change over a period of time. There are many conditions that can cause an **increase** or **decrease** in the size of the population. Changing conditions may include disease, food supply, temperature, weather, availability of space, migration, and pollution.

To better understand population changes, a team of biologists studied yeast for 10 days. Yeast were chosen because they are rapidly growing organisms that can be grown in sealed test tubes, with sugar as their food supply. At the beginning of the study, three populations of the same size were then given a different amount of sugar. You will perform several tests using your laboratory skills. You will collect and examine data to determine the following:

- changes in the environment due to carbon dioxide production
- amount of sugar remaining after each day
- population size

Using this information, you will do the following:

- Determine how changing conditions affect the size of the yeast population.
- Use data you collect from day 4 and day 8 to predict changes in population size, pH, and sugar for unknown days 5, 6, 7, 9, and 10.
- Predict the effects of changing conditions on the population of another species.

PART A

pH of Solution

1. Yeast produce carbon dioxide as one of the waste products of respiration. Carbon dioxide dissolves in water to form carbonic acid. The more carbon dioxide produced, the more acidic the liquid becomes, lowering the pH.

   The pH is a measure of the acidic or basic nature of a solution. The more acidic the solution, the lower the pH.

   You will conduct a pH test on yeast samples collected from Population Z on day 4 and day 8.

   a. Determine the pH of the sample using "Yeast Population Z Day 4," pH paper, the pH scale card, and the well tray.

   b. Save the liquid in the well tray for the sugar test.

   c. Record your data in Table 1, pH for Population Z.

   d. Repeat steps a through c for "Yeast Population Z Day 8."

Table 1. pH for Population Z

Day	1	2	3	4	5	6	7	8	9	10
pH	7	6.5	6.5		?	?	?		?	?

The question marks (?) represent unknown data points that you will predict on the graph in Figure 3 on page 5.

e. Plot the data you collect for Table 1 in Figure 3 on page 6. Draw a best-fit line through the data points for days 4 through 10.

2. Briefly describe the procedure you used to determine the pH of the sample containing Population Z.

3. Compare populations X and Y in figures 1 and 2 on page 6. Describe the relationship between pH and the change in population size from day 1 through day 10.

Sugar Analysis

4. At the beginning of the study, each population was given a different amount of sugar. This was done to observe the effects of different amounts of sugar on population growth. To determine the amount of sugar remaining, you will test samples that have been collected from population Z on day 4 and day 8.

a. To test for the amount of sugar remaining on day 4, use the sample solution in your well tray from Population Z, day 4, the sugar test solution, and the sugar color chart below.

Chart 1. Sugar Color Chart

Color	Black	Blue	Red	Orange	Brown
Sugar Remaining g/L	5	4	3	2	1

b. Record your data in Table 2 below.

c. Repeat steps a and b for day 8.

Table 2. Sugar for Population Z (g/L)

Day	1	2	3	4	5	6	7	8	9	10
Sugar	5	4.5	4	?	?	?	?	?		

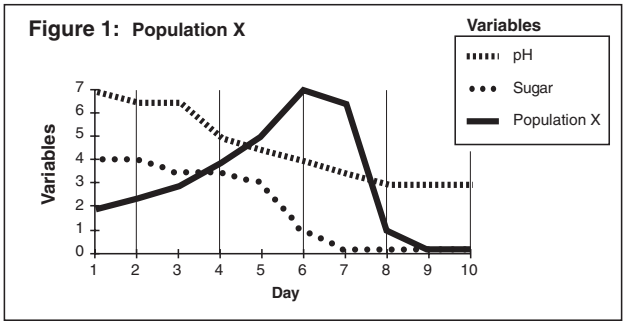
The question marks (?) represent unknown data points that you will predict on the graph in Figure 3 on page 6.

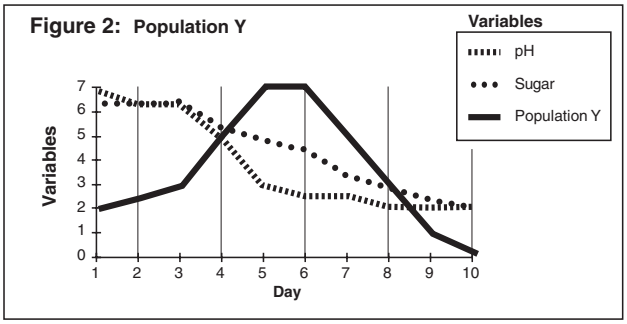
d. Plot the data in Table 2 on the graph in Figure 3 on page 6. Draw a best-fit line through the data points.

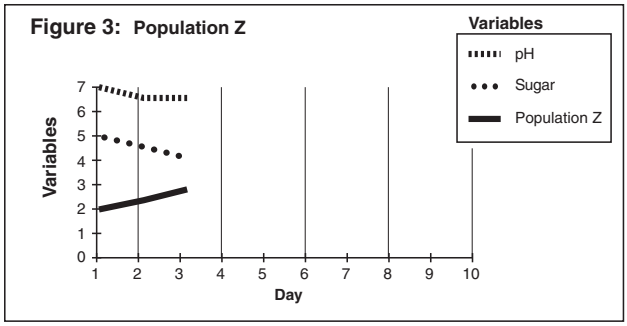
5. Briefly describe the procedure you used to determine the amount of sugar remaining in the sample containing Population Z.

6. Compare populations X and Y from day 1 through day 10 in figures 1 and 2 on page 6. In the space below, describe the **relationship between the amount of food and the change in population size.**

7. Using Figure 1, Population X, on page 6, decide whether sugar or pH had the greatest effect on the change in population size from day 1 through day 10. Give a detailed explanation for your choice in the space below.







Population Size

8. Using the data you collected and graphed for the sugar and pH tests, write your prediction on what will happen to Population Z for day 4 through day 10. Give reasons that support your predictions.

9. The yeast populations were grown in a water environment in test tubes. Sugar was added as a food supply. The yeast, which are suspended in the water, appear as a cloudy mixture. The more yeast there are, the more cloudy the liquid in the test tube.

   You will use a simulated slide to determine the size of Population Z, which has been prepared for you. This represents a one mL sample of Population Z spread across the slide.

   a. To determine the size of Population Z, lay the center of the slide "Yeast Sample Day 4" over number 6 in Chart 2, Population Size Scale, below. Slowly move the slide over each number until you get to the lowest number you can most clearly read through the yeast sample.

   b. Record your results in Table 3 below for day 4.

   c. Repeat steps a and b for day 8 using the slide "Yeast Sample Day 8."

Chart 2. Population Size Scale

Table 3. Size of Population Z (millions/milliliter)

Day	1	2	3	4	5	6	7	8	9	10
Population	2	2.5	3	?	?	?	?	?		

The question marks (?) represent unknown data points that you will predict on the graph in Figure 3 on page 6.

10. Plot the data from Table 3 on the graph in Figure 3 on page 6. Using the data collected and your observations of populations X and Y, draw a line that shows the most likely change in Population Z from day 4 through day 10.

11. Explain how your prediction in question 10 **is** or **is not** supported by the data you collected and graphed.

PART B

Make your answer detailed and complete.

Algae are growing out of control in a lake as fertilizers from the nearby farms run into the lake. Algae are a part of the food web in the lake, but as excess algae grow, fish and other organisms are unable to survive.

Using the information you gained from this lab task and your knowledge of population ecology, propose a solution to this problem:

Give two reasons why your solution would help solve the problem.

Discuss at least two effects of your solution on the lake ecosystem.

Sample Multiple-choice Questions for Chemistry

1. A piece of metal, heated in air, increases in mass as it changes from a shiny gray solid to a white powder. We can conclude that

   A. the metal was reduced.

   B. the metal decomposed.

   C. a compound formed.

   D. a physical change took place.

2. In comparing 1.00 mole of nitrogen monoxide gas (NO) and 1.00 mole of carbon dioxide gas (CO 2), each at 25°C and 1.00 atmosphere, which of the following is true?

   A. They have the same mass.

   B. They have the same number of atoms.

   C. They have the same volume.

   D. They have the same average molecular speed.

3. **Structure of Different Atoms or Ions**

Atom or ion sample	Number of protons	Number of neutrons	Number of electrons
q	1	0	1
r	1	0	0
s	1	1	1
t	2	1	2
u	2	2	2
v	17	20	17
w	17	20	18

Which pairs are different isotopes of the same element?

   A. **q** and **r** of one element; **v** and **w** of another element

   B. **q** and **r** of one element; **t** and **u** of another element

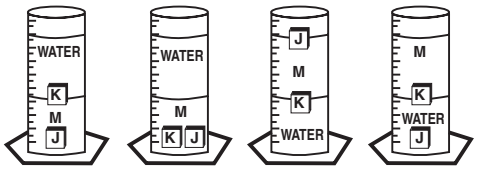
   C. **t** and **u** of one element; **v** and **w** of another element

   D. **q** and **s** of one element; **t** and **u** of another element

4. Refer to the following data table.

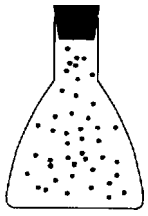
Substance	Mass (grams)	Volume (mL)
solid J	20.3	7.5
solid K	6.0	7.5
liquid M	5.0	7.5
water	7.5	7.5

Which diagram below is correct?

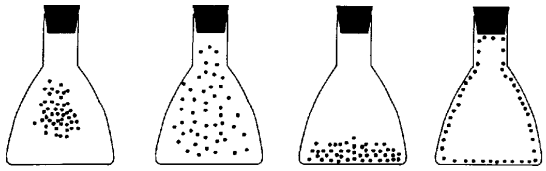


A. B. C. D.

5. The following diagram represents a sealed flask filled with helium (He) gas at 20°C. (The dots represent the helium atoms.)

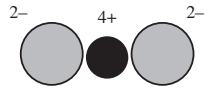


Which diagram BEST illustrates the distribution of helium atoms in the flask when the temperature is lowered to –20 °C and helium remains a gas?



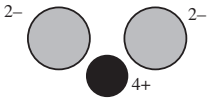
A. B. C. D.

6. Carbon disulfide (CS_2) is nonpolar. The molecular shape consistent with this observation is:

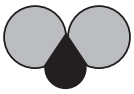


A. linear and ionic

B. linear and covalent



C. angular (bent) and ionic



D. angular (bent) and covalent

7. **Melting Points of Elements**

Nitrogen -210 °C	Oxygen -218 °C	Fluorine ?
		Chlorine -110 °C
		Bromine ?

Consider the melting points of the elements shown in the chart above. Which values would you predict for fluorine and bromine?

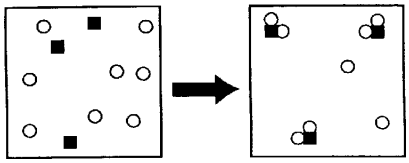
A. fluorine, –189 °C; bromine, 113 °C

B. fluorine, 113 °C; bromine, –189 °C

C. fluorine, –7 °C; bromine, –220 °C

D. fluorine, –220 °C; bromine, –7 °C

8. The reaction of element X (■) with element Y (o) is represented in the following diagram.



Which equation properly describes the reaction between X and Y?

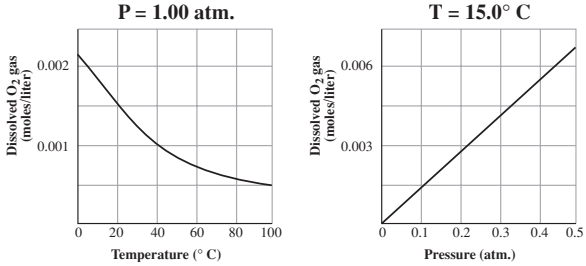
A. $3X + 8Y \longrightarrow X_3Y_8$

B. $3X + 6Y \longrightarrow X_3Y_6$

C. $X + 2Y \longrightarrow XY_2$

D. $3X + 8Y \longrightarrow 3XY_2 + 2Y$

9.



The graphs above show the effect of temperature or pressure on the solubility of oxygen gas (O_2) in water. Dissolved oxygen is measured in moles/liter.

Which of the following conditions would increase the solubility of oxygen gas?

A. Decrease temperature and decrease pressure.

B. Decrease temperature and increase pressure.

C. Increase temperature and decrease pressure.

D. Increase temperature and increase pressure.

Chemistry Answer Key

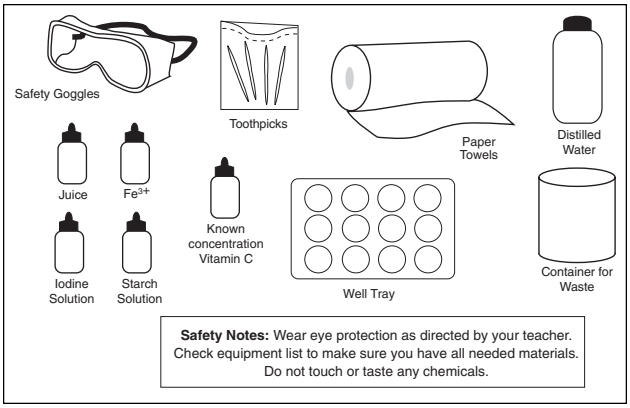
1. C	4. D	7. D
2. C	5. B	8. C
3. D	6. B	9. B

Sample Laboratory Task for Chemistry

Title: Vitamin C Analysis

Laboratory Materials

On the table in front of you, you will find the following:



This task consists of a laboratory experiment, Part A, and an application question, Part B. They will be scored separately. Your final score will be based on your answers to both Part A and Part B. You should plan on spending about 30 minutes on Part A and 15 minutes on Part B.

Directions

These instructions will not be repeated during the procedures.

Read and follow the steps of this lab in the order given.

Record all observations, results, and answers to the questions as directed.

Immediately notify your instructor of spills, missing equipment, or other problems.

STATEMENT OF THE TASK

Vitamin C, also known as ascorbic acid, is an important part of a healthy diet since humans cannot make Vitamin C in their bodies. The major functions of Vitamin C are to promote healing and fight infections. It has other functions in the body related to its strong tendency to release electrons in chemical reactions. Without Vitamin C, people develop a condition known as scurvy. Symptoms of scurvy include bleeding gums, swollen joints, and the slow healing of wounds.

Vitamin C is the least stable of all vitamins. It readily reacts with oxygen and other oxidizing agents and breaks down when exposed to heat and light. It is water-soluble and cannot be stored in the body. Any excess is excreted with other liquids. Therefore it is necessary for humans to ingest some Vitamin C every day. The U.S. Government's Recommended Dietary Allowance (RDA) for adults (16 years and older) is 60 milligrams per day.

In this investigation you will analyze the amount of Vitamin C in juice through titration, study the effect of a metal ion on Vitamin C, and make recommendations regarding the packaging and storage of a drink containing Vitamin C.

PART A

To determine the Vitamin C content, you will be reacting the solution with the oxidizing agent, iodine. The reaction is given below:

$$\underset{\text{Vitamin C}}{C_6H_8O_6} + \underset{\text{iodine}}{I_{2(aq)}} \rightarrow \underset{\text{dehydroascorbic acid}}{C_6H_6O_{6(aq)}} + \underset{\text{iodide ion}}{2I^-_{(aq)}} + \underset{\text{hydrogen ion}}{2H^+_{(aq)}}$$

Starch is added to provide a color change to signal the titration endpoint. Once all of the Vitamin C has been reacted, starch reacts with iodine as shown below:

$$\underset{\text{yellow-brown}}{I_{2(aq)}} + \text{starch}_{(aq)} \rightarrow \underset{\text{blue-black}}{\text{starch}\text{–}I_{2(aq)}}$$

Therefore, the first sign of the blue-black color indicates the endpoint.

Determining the Iodine to Vitamin C Relationship Through Titration

1. Using the known concentration of Vitamin C solution, add 10 drops of the solution to one well and 10 drops to a second well.
2. Add 2 drops of starch solution to each of these wells.

3. To one of the wells, add 1 drop of iodine (I_2) solution. Using a toothpick, stir to mix the solutions completely. Continue to add iodine solution, 1 drop at a time, until the solution in the well remains blue-black even after thorough stirring. Record the number of drops used in Table 1.
4. Repeat step 3 for the second well. Use a **clean** toothpick for stirring.

Table 1. Observations

Trial Number	Vitamin C concentration	Vitamin C (# of drops)	Iodine (# of drops)
Trial 1	7.02×10^{-3} mg/drop		
Trial 2	7.02×10^{-3} mg/drop		

5. Calculate the total number of milligrams of Vitamin C present in 10 drops of Vitamin C solution, using the concentration given in Table 1. Show your work in the space below.
6. Calculate the milligrams of Vitamin C that react per drop of iodine solution for each trial. Show your work in the boxes on the next page.

Trial 1	
Trial 2	

Average of the results of the two trials _____

7. Explain why it was important to run 2 trials and average the results.

Determining Vitamin C Content in Juice

8. Add 10 drops of the juice sample and 2 drops of starch solution to each of 2 clean wells. Stir each mixture with a **new** toothpick.
9. To one of these wells, add iodine solution, 1 drop at a time, stirring after each drop, until the solution remains blue-black. Record the number of drops of iodine solution used in Table 2.
10. Repeat step 9, using a new toothpick, for the other well.

Table 2. Observations

Trial Number	Juice (# of drops)	Iodine (# of drops)
Trial 1		
Trial 2		

Determining the Effect of Fe^{3+} on Vitamin C

11. Add 10 drops of juice and 2 drops of the solution containing Fe^{3+} to each of 2 clean wells. Stir each mixture with a **new** toothpick.
12. Allow this mixture to stand for several minutes. You will be returning to these for further analysis in step 16.

* * * * *

13. Calculate the milligrams of Vitamin C in the 10 drops of juice for each trial (steps 9 and 10). Use your calculated value from question 6. Show your work in the boxes below.

Trial 1	
Trial 2	

Average of the results of the two trials _____

14. Given that 20 drops of juice = 1 mL, determine the number of milligrams of Vitamin C per mL for the juice. Show your work in the space below.
15. The current RDA for Vitamin C is 60 milligrams. How many mL of the juice you analyzed would you have to drink to meet the daily Vitamin C requirement? Show your work in the space below.
16. Return to the wells containing the Fe^{3+} and juice solutions. Add 2 drops of starch solution to **each** of these wells.
17. To one of these wells, add iodine solution, one drop at a time, stirring well after each addition. Continue to add iodine solution until the solution remains blue-black after thorough stirring. Record the number of drops of iodine used in Table 3.

18. Repeat step 17, using the solution in the remaining well and a **clean** toothpick.

19. Compare your results in tables 2 and 3. Explain any differences.

Table 3

Trial Number	Juice (# of drops)	Fe^{3+} Solution (# of drops)	Iodine (# of drops)
Trial 1			
Trial 2			

PART B

Make your answer detailed and complete.

A food company is about to market a new breakfast drink advertised as a wonderful source of Vitamin C. They are concerned about the stability of the Vitamin C in the product. They are considering various forms of packaging: steel (contains iron), plastic, and cardboard containers.

You have been hired as a consultant to make recommendations about the packaging and storage for this new product.

Figure 1 shows cost of manufacturing l-liter containers of various materials.

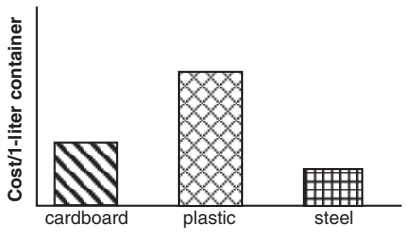


Figure 1. Cost of Manufacturing Containers

Figure 2 shows the effect of heat and light separately on two samples of Vitamin C.

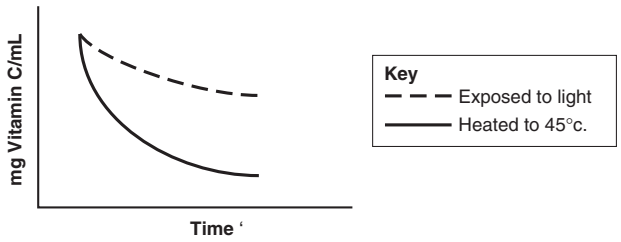


Figure 2. Effect of Heat and Light on Vitamin C

A. Based on your information from the laboratory task, cost (Figure 1), and environmental impact, what type of container would you recommend? Explain your choice and reasons for **not** selecting the other two materials.

B. Using the information in Figure 2, what additional recommendations would you make concerning the packaging and storage of the breakfast drink? Explain your reasoning.

Sample Multiple-choice Questions for Second-year Coordinated Science

1. A student is experimenting with a potato and salt solution. A fresh slice of potato weighs 3.5 grams. The slice is then placed in a beaker containing 60% salt solution. After 15 minutes the slice is removed and weighed again. What is the most likely result?

   A. 3.0 g

   B. 3.5 g

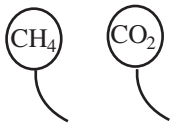
   C. 4.0 g

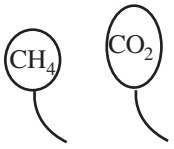
   D. 7.0 g

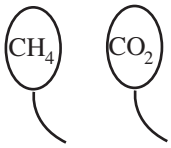
2.

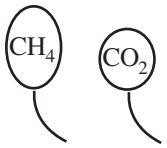
GAS	DENSITY (g/L)
air	1.21
methane (CH_4) (molar mass = 16)	0.668
carbon dioxide (CO_2) (molar mass = 44)	1.84

What would be the relative sizes of the same balloons after several days?

A. 

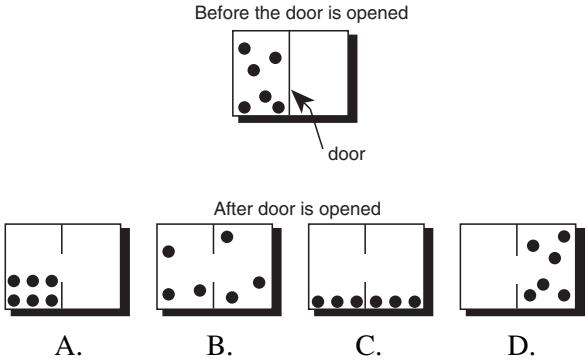
B. 

C. 

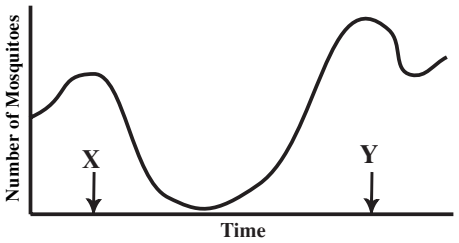
D. 

3. The dots in the diagrams below represent gas molecules trapped in a box.

   What is the MOST likely arrangement of gas molecules in the box after the door separating the two sides is opened?



4. **Effects of Pesticides on Mosquito Populations**



A pesticide was sprayed at time X and again at time Y. Many of the mosquitoes were killed after the first spraying.

Which of the statements below BEST explains the shape of the graph above?

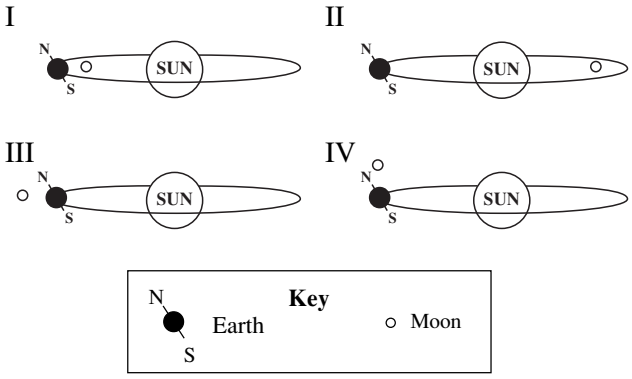
A. Offspring of the survivors are weakened and killed by the second spraying of the pesticide.

B. Offspring of the survivors are unable to reproduce.

C. Offspring of the survivors are better able to survive the pesticide.

D. The survivors are unable to reproduce offspring.

5.



Which diagram above shows the spatial relationship between the sun, the moon, and the Earth during the highest tides along the equator?

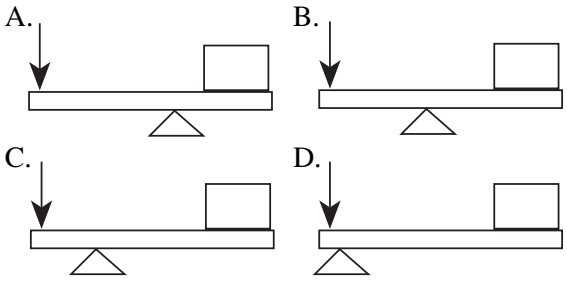
A. I

B. II

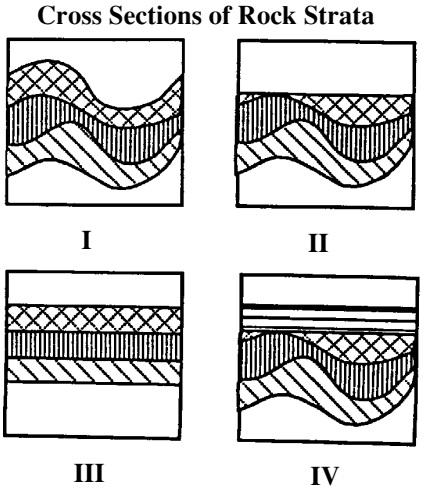
C. III

D. IV

6. A heavy box is placed on a lever. In which diagram will the SMALLEST amount of DOWNWARD force at the arrow move the box UPWARD?



7. In which order would the diagrams below show the sequence of events through time?



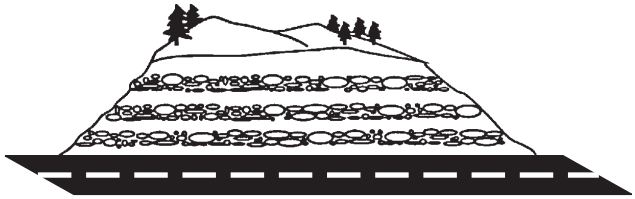
A. I, II, III, IV

B. III, II, IV, I

C. III, I, II, IV

D. IV, II, III, I

8. A road is cut through a hill. The diagram below represents the cut hillside on the side of the road. It shows layers of rounded boulders separated by layers of hardened dirt.



This site was probably a former

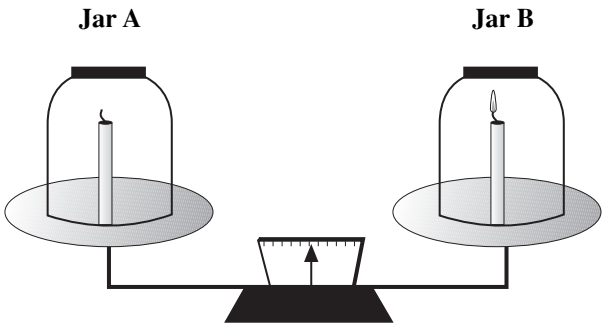
A. fault zone.

B. ocean floor.

C. volcanic magma chamber.

D. river bed.

9.



Two identical candles are placed in identical jars on a balance, as shown in the diagram above. The candle in Jar B is lit and both jars are tightly closed. After 5 minutes, you should observe that Jar B is

A. higher than Jar A.

B. at the same height as Jar A.

C. lower than Jar A.

D. continually adjusting its height.

Second-year Coordinated Science Answer Key

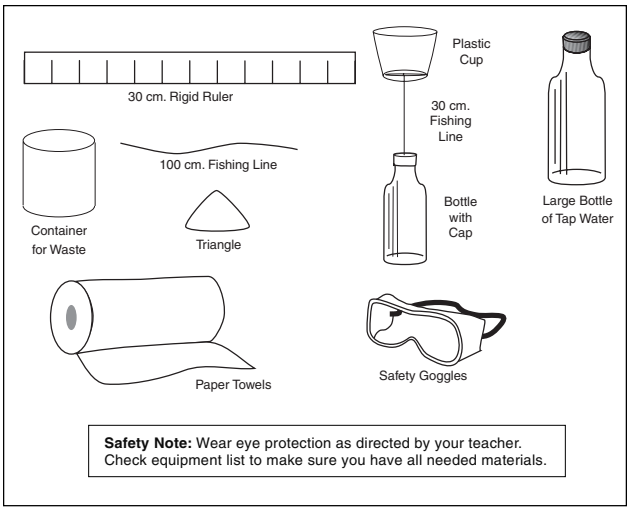
1.	A	4.	C	7.	C
2.	B	5.	A	8.	D
3.	B	6.	A	9.	B

Sample Laboratory Task for Second-year Coordinated Science

Title: "Properties of Sound"

Laboratory Materials

On the table in front of you, you will find the following:



This task consists of a laboratory experiment, Part A, and an application question, Part B. They will be scored separately. Your final score will be based on your answers to both Part A and Part B. You should plan on spending about 30 minutes on Part A and 15 minutes on Part B.

Directions

These instructions will not be repeated during the procedures.

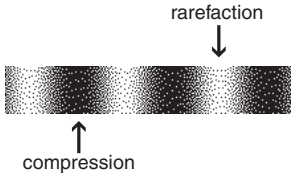
Read and follow the steps of this lab in the order given.

Record all observations, results, and answers to the questions as directed.

Immediately notify your instructor of spills, missing equipment, or other problems.

STATEMENT OF THE TASK

Sound travels in waves that have amplitude, wavelength, speed, and frequency (pitch). Sound waves can be represented as in this diagram:



In this investigation you will observe some properties of sound and will apply these observations to a potential human communication problem.

PART A

1. Make observations of a vibrating ruler.
   a. Find the ruler on the table in front of you.
   b. Place the ruler on the table so that 25 cm of the ruler hangs off the table (Figure 1).

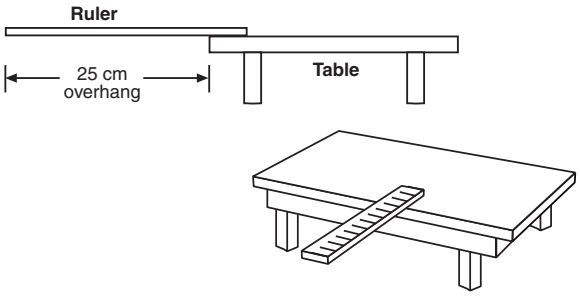
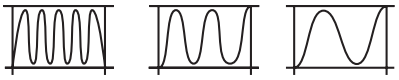


Figure 1. Placement of Ruler on Table

   c. Holding the ruler down on the table with one hand, gently pull down on the end of the ruler that hangs off the edge of the table. Quickly release the overhanging end.

Pitch can be given the name of a note on a musical scale.
Pitch is different from loudness.
Frequency is the number of waves that pass a given point in a given period of time.



1 sec high pitch | 1 sec medium pitch | 1 sec low pitch

(1-second intervals)

Figure 2. A Model of the Relationship Between Pitch and Frequency

d. Notice whether you are hearing a high pitch sound or a low pitch sound.

e. Notice the up and down motion (frequency) of the ruler when you release the overhanging end.

f. Refer to Figure 2 and record your observations in Table 1.

g. Decrease the length of ruler that hangs off the table.

h. In Table 1 record the new length that hangs off the table.

i. Repeat steps c through f with shorter lengths of the ruler hanging off the table edge, stopping at 10 cm.

Table 1. Observations

	Trial 1	Trial 2	Trial 3
Length of ruler (cm) that is hanging over the table	25		
Observations: high pitch, low pitch			
Relative number of up and down motions of the ruler			

Think about:

- what is happening to the particles in the ruler that is causing the sound.
- how you hear the sound through the air.
- what is causing the high pitch and the low pitch you hear.

j. In the box below, write your explanation of what is happening when the ruler creates sound, how the sound reaches your ear, **and** the relationship between the length of the ruler that hangs off the table and the pitch of sound that you hear.

2. Make observations of sound transmission in different substances.

Among your materials there is a long (100 cm) piece of fishing line.

a. Loop it once through one of the angles of the metal triangle.

b. Listen to the sound made when you gently tap the metal triangle against the side of the table while you hold the ends of the fishing line.

c. Record your observations in Table 2 below.

d. Hold an end of the fishing line against the opening of each ear (Figure 3).

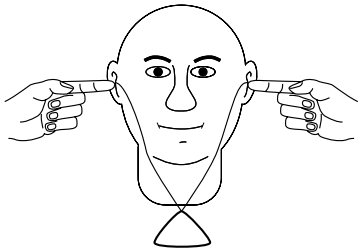


Figure 3

e. Gently tap the metal against the side of the table.

f. Record your observations in Table 2 below.

Table 2. Observations

	Sound through air	Sound through fishing line
Observations: (pitch and loudness)		

g. In the box below:

- Compare the sound heard through the air to that heard through the fishing line.
- Decide which material (air or fishing line) transmits more sound to your ear.

3. A recent article in Science News described an experiment that sent sound waves through air, liquid water, and ice. Table 3 below shows some of the results of this experiment.

Table 3. Results of Speed of Sound Experiment

	Speed of sound (m/s)
Air	340
Liquid water	1200
Ice	

a. Look at the values included in Table 3.

b. A possible value for the speed of sound in ice is: (circle the correct answer)

a. 34.0 m/s b. 1200 m/s c. 3400 m/s

c. Explain in the box below your reasons for choosing this answer. Include in your description the relationship between speed of sound and distance between particles in air, water, and ice.

d. How do the observations you recorded in Table 2 relate to the results listed in Table 3?

Write your answer in the box below.

4. Make observations of vibrations of stretched fishing line.

a. If you are the first person to use this kit, thread the 30 cm fishing line through the cup and the bottle cap as shown in Figure 4. If you are not the first person using the kit, find the cup with the 30 cm fishing line attached to a bottle.

b. Unscrew the cap from the bottle and fill the bottle to the line. Put the cap back on.

c. Hold the cup in one hand so that the bottle hangs straight down and does not touch another object.

d. Hold the cup next to your ear so that you can see the water in the bottle (Figure 4).

e. Use a finger of the hand that is not holding the cup to scrape across the fishing line. Quickly release the fishing line.

f. Listen to the **pitch** of the sound that reaches your ear.

g. Observe the movement of the water in the bottle.

h. Record your observations in Table 4 below.

i. Pour half the water into the waste container and replace the cap.

j. Repeat steps c through h.

Figure 4

Table 4. Observations with 30 cm Fishing Line

Observations	**Full bottle of water** (high tension in fishing line)	**Half bottle of water** (low tension in fishing line)
Pitch: high/low		
Water motion: tall/short; slow/fast		

k. In the box below, sketch a graph to show the relationship between pitch and tension in the fishing line.

5. Make observations of vibrations as the length of fishing line changes.

   a. Use the same cup and half-full bottle and repeat the last procedure (4c through 4g). Enter your observations in Table 5 on the next page.

   b. Pull the fishing line through the cup so that it is half as long between the cup and the bottle. DO NOT change the amount of water in the bottle.

   c. Repeat the procedure and enter your observations in Table 5 on the next page.

Table 5. Observations with Half-full Bottle of Water

Observations:	**30 cm fishing line**	**15 cm fishing line**
Pitch: high/low		
Water motion: tall/short; slow/fast		

d. What conclusions can you reach about the relationship between the length of fishing line and the pitch it produces when scraped? Write your answer in the box below.

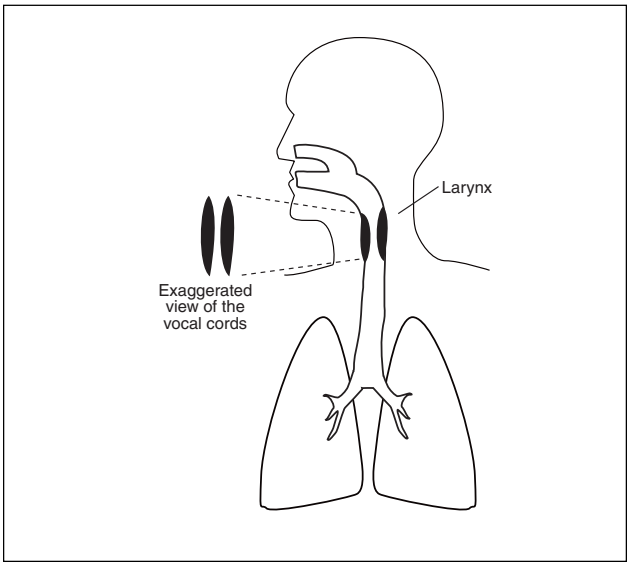
PART B

Make your answer detailed and complete.

A human can communicate by pushing air from the lungs past the vocal cords in the larynx, a structure in the throat, sometimes called "the voice box."

Laryngitis is a swelling or inflammation of the vocal cords. This can cause the vocal cords to lose their ability to vibrate so people "lose their voices."

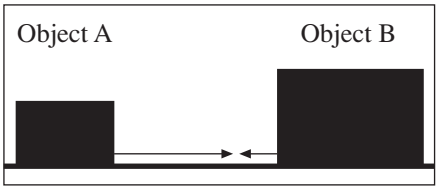
Imagine that a person has suffered severe damage to the larynx and needs new vocal cords.



Using your observations from this lab task and your knowledge of science, suggest characteristics of an ideal replacement material for the damaged vocal cords so that a high-pitched voice results. What would be changed to create a low-pitched voice?

In your answer be sure to include a description of the type of material, its length, and its tension.

Sample Multiple-choice Questions for Physics

1. 

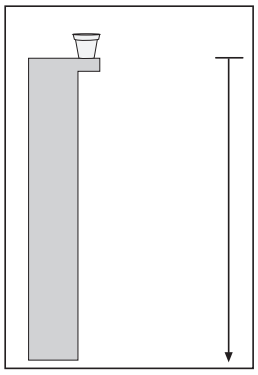
A 30 kg object (object A) sliding at 8 m/s across a frictionless surface collides head-on with a 60 kg object (object B) sliding at 2 m/s in the opposite direction. During the collision, the force of object A on object B

A. is one quarter the force of object B on object A.

B. is one half the force of object B on object A.

C. is equal to the force of object B on object A.

D. is twice the force of object B on object A.

2. 

A flower pot falls from a window ledge 5 meters above the sidewalk. How fast is the flower pot moving just before it hits the sidewalk? (Use 10 m/s^2 for g.)

A. 5 m/s

B. 10 m/s

C. 15 m/s

D. 50 m/s

3. A ball weighing 4 N is dropped off of a high cliff. As it falls, it encounters 1 N of air resistance. The net force on the object is

A. 3 N upward.

B. 3 N downward.

C. 5 N upward.

D. 5 N downward.

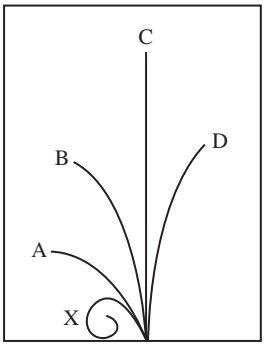
4. The increase in the kinetic energy of an object is equal to

A. the net impulse imparted to the object.

B. the increase in the velocity of the object.

C. the power expended divided by the elapsed time.

D. the net work done to increase the speed of the object.

5. 

Particles of the same speed are shot into a magnetic field perpendicular to the page in a detector that reveals their tracks as shown in the diagram above. If track X is made by an electron, which is the track left by a proton?

A. Track A

B. Track B

C. Track C

D. Track D

6. In charging a neutral object by induction using a positively charged comb,

   A. the object becomes positively charged without being touched by the comb.

   B. the object becomes negatively charged without being touched by the comb.

   C. the object separates the charges on the comb.

   D. the object first gains then loses protons.

7. To double the current through a resistor in a circuit,

   A. double the voltage across the resistor.

   B. double the resistance of the resistor.

   C. double the voltage across the resistor and double the resistance.

   D. double the resistance and decrease the voltage across it by half.

8. The time that elapses between the arrival of a wave crest and the next wave crest is the

   A. amplitude.

   B. pulse width.

   C. frequency.

   D. period.

Note: The GSE in physics is a new examination; therefore, a sample laboratory task is not available.

Physics Answer Key

1.	C	4.	D	7.	A
2.	B	5.	D	8.	D
3.	B	6.	B		

The page shown below may be included in each test booklet for the student to use as a reference.

Periodic Table of the Elements

1 H 1.008																	2 He 4.003
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.70	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (97)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.4	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30
55 Cs 132.91	56 Ba 137.33	57 *La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.2	77 Ir 192.22	78 Pt 195.09	79 Au 196.97	80 Hg 200.59	81 Tl 204.37	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.03	89 **Ac (227)	104 Rf (261)	105 (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)									

*Lanthanide Series

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (147)	62 Sm 150.4	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97

**Actinide Series

90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (254)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

Units, Definitions, and Abbreviations

L = liter
mL = milliliter
1 L = 1000 mL

m = meter
cm = centimeter
mm = millimeter
nm = nanometer
Å = Angstrom
1 m = 100 cm = 1000 mm = 10^9 nm = 10^{10} Å

g = gram
kg = kilogram
1 kg = 1000 g

s = second

mol = mole
M = molar = moles per liter

°C = degrees Celsius
K = degrees Kelvin

kPa = kilopascal
atm = atmosphere
mm Hg = millimeters of mercury

J = joule
kJ = kilojoule
4.18 J = 1 calorie (cal)

E° = standard reduction potential
V = volt

STP = Standard Temperature and Pressure
standard temperature = 0 °C = 273 K
standard pressure = 760 mm Hg = 1 atm = 101.3 kPa

$PV = nRT$

n = number of moles of gas
R = gas constant
= 0.0821 L • atm • mol^{-1} • K^{-1}
= 8.31 J • mol^{-1} • K^{-1}

$D = \frac{\text{mass}}{\text{volume}}$